REFERENCE STANDARDS OF ANTHROPOMETRIC MEASUREMENTS FOR CHILDREN 0-2 YEARS AGE, OF AN URBAN SET UP

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Certificate

Certified that this dissertation entitled **"REFERENCE STANDARDS OF ANTHROPOMETRIC MESUREMENTS FOR CHILDREN 0-2 YEARS AGE, OF AN URBAN SET UP"** is a bonafide work done by **Dr.P.SIVA BHARATHI,** Postgraduate student of Paediatric Medicine, Institute of Child Health and Hospital for Children, Egmore, Chennai–8 attached to Madras Medical College, during the academic year 2004-2007.

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DECLARATION

I declare that this dissertation entitled "**REFERENCE STANDARDS OF ANTHROPOMETRIC MEASUREMENTS FOR CHILDREN 0-2 YEARS AGE, OF AN URBAN SET UP"** has been conducted by me at the Institute of Child Health and Hospital for children, under the guidance and supervision of my unit chief **Prof. C.D.NATARAJAN M.D., D.C.H.,** and overall supervision of director & superintendent **Prof.Dr. KULANDHAI KASTHURI, M.D., DCH**.

It is submitted in part of fulfillment of the award of the degree of M.D [Pediatrics] for the March 2007 examination to be held under The Tamil Nadu Dr. M.G.R. Medical University, Chennai. This has not been submitted previously by me for the award of any degree or diploma from any other university.

Dr. P. SIVA BHARATHI

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CONTENTS

INTRODUCTION

Substantial reductions in the mortality of infancy and early childhood have been achieved throughout the world in recent decades. Unfortunately, this achievement has not been accompanied always by a corresponding improvement in the level of health of surviving children. A major reason for this paradox is the failure to balance the advances in therapeutic care with effective measures for disease prevention. Despite considerable progress in the application of medical technology at the local level, simple and tested methods of health promotion are not being applied systematically on a widespread scale [(3)]. This results more often from lack of technical guidance and motivation than from a deficiency of material resources. The systematic use of growth charts in maternal and child health care is a specific example, which will help to promote health in children.

The growth chart offers a simple and inexpensive means of monitoring child health and nutritional status in local health services and can be utilized with minimal instruction and supervision. The chart represents a convenient means of organizing and presenting basic health data and permits the

assessment of current status as well as the observation of trends in growth performance[3]. It facilitates the classification of nutritional status and thus provides an objective basis for decision-making in relation to care. The precise criteria that are used to interpret growth chart data and to define the levels of care required must, however, be determined on the basis of local needs, resources and service patterns.

Because of its essentially visual character the chart provides the health worker with a useful instrument for educating the mother and the family. It promotes a clearer understanding of the nature of growth (and development) and portrays clearly the consequences of an inadequate diet and infectious diseases[3]. In this way it contributes to greater acceptance of responsibility for child care by the mother and to the concept of family self-reliance in health matters.

The assumption that all children have the same genetic potential especially in the early childhood and their growth is more influenced by nutrition, illness and environment rather than by heredity and the observation that growth of well-nourished children in the developing countries compares favorably with that of the developed world's children. WHO has advocated the use of

NCHS[19] data as a single international reference data.[20] Some authorities have argued that the use of reference standard derived from a developed country or for the affluent class in the developing countries, becomes a very high standard which is impossible to reach by the unprivileged children of developing countries and proposed to evolve own reference standards to be more realistic about their potential growth achievements.

To assess the true magnitude of growth retardation and under nutrition a single reference standard will give uniform and comparable data than the different lower standards used. The purpose will be defeated by deliberately adopting a lower standard which does not reflect the fully genetic potential for growth. Studies conducted in different countries showed that ethnic differences in growth are minimal. However, one cannot deny the need for local data for any country or region for future comparison. In India, ICMR [21] standards were used – undoubtedly, under heavy criticism for the samples and collection of data.

It is clear that local reference standards should be utilized for the purpose of comparison. Arguments in favor of local reference include: (i) There is no certainty that the growth of NCHS data base is optimal – they may well be too fat; and bigger is not

necessarily better; (ii) Use of a local standard will provide a picture of the average in a country in order to identify groups or individuals who are above or below the average. It is felt that selection of malnourished children by anthropometric variables can only be done successfully by “local references” which represent “acceptable growth in a given environment”. (iii) In most of the developing countries, growth failure in children is widespread and severe. Estimates of malnutrition on the basis of NCHS reference would, therefore, “overestimate” the true extent of the problem. Similarly, planners may find targets based on NCHS standards [(1)] unrealistic and unattainable.

Many developing countries are experiencing secular trends of increasing weight and height, making it necessary to update local population – average references after several years.

The objective of the growth chart is to promote healthy growth by increasing the level of awareness and knowledge of the family and the health worker, through the graphic presentation of simple body measurements. The chart is designed to enable the service worker to assess normal growth, and to determine deviations in individuals and interpret these in terms of health status, as well as to make decisions regarding alternative types of

care and referral procedures if required. The chart may also be used to monitor growth at the community level as a contribution to health surveillance. On the basis of information gained from such uses of the chart, service personnel should be able to influence planning and policy-making at the local and central levels.

The chart provides the mother with a visual record of the nutritional and health status of her child, together with a history of important events, such as immunizations, breast-feeding, introduction of supplementary foods and child spacing. It also offers a means of assuring continuity of care between the various levels and types of service with which the child has contact. Finally, it should serve as a useful vehicle for health education through person-to person communication at the household level.

OBJECTIVES OF THE STUDY

To construct percentile charts for various anthropometric measurements (weight, length, head circumference, chest circumference, & mid arm circumference) for 0-2yrs age group children and comparing them with NCHS standards.

GROWTH

DEFINITION:-

Growth and development begins at the moment of conception and are continuous processes, until the epiphyses fuse and growth in height ceases. The term growth denotes increase in size or body mass and development is the emerging and expanding capacities of the individual to provide progressively greater faculties in functions, i.e. acquisition of a variety of competencies for optimal functioning in a social milieu. [22]

Control of body movements is through the coordinated activities of nerves, nerve centers and the muscles. These motor movements develop in a definite sequence and the direction being cephalocaudal. The first step in gross motor development is head control, involving the neck muscles. It is development of spinal muscle coordination that makes child sit with straight back instead of a round one. Child develops coordinated movements of hands, allowing him to crawl, followed by the leg movement, e.g. standing and walking. The development is proximodistal also, e.g. movement coordination develops first in the trunk muscle followed

by shoulder, arm, hand and fingers. The aimless movement of arms and legs of the first six months are replaced by the specific movements of locomotion and manipulation.

GROWTH PATTERNS

Growth is a process rather than a static quality. An infant at the 5th percentile of weight for age may be growing normally, may be failing to grow, or may be recovering from failure, depending on the trajectory of the growth curve. Typically, infants and children stay within one or two growth channels [6]. This canalization attests to the robust control that genes exert over body size.

A normal exception commonly occurs during the 1st 2 yr of life. For full-term infants, size at birth reflects the influence of the uterine environment; size at age 2 yr correlates with mean parental height, reflecting the influence of genes. Between birth and 18 months, small infants often shift percentiles upward toward their parent's mean percentile. Large neonates with smaller parents often shift downward, with decelerating growth beginning at 3-6 months and ending as an infant achieves a new growth channel at approximately 13 -18 months[6] .

The analysis of growth patterns provides critical information for the diagnosis of *failure to thrive* (FTT). There is no universally agreed-on criterion for FTT or growth failure; most consider the diagnosis if a child's weight is below the 5th percentile or drops down more than two major percentile lines [(6)].

Weight for height below the 5th percentile remains the single best growth chart indicator of acute under nutrition. Children who have been chronically malnourished may be short as well as thin, so that their weight for height curves may appear relatively normal. Chronic, severe under nutrition in infancy can also depress head growth, an ominous predictor of late cognitive disability .

When growth parameters fall below the 5th percentile, it becomes necessary to express the values as percentages of the median or standard value. For example, a 12 month old girl weighing 7.1 Kg is at 75% of the median weight (9.5Kg) for her age. Using the calculated percentage of standard rather than the percentile, growth failure can be graded from mild to severe according to the table-1. These designations correlate with the

risk of mortality in developing countries. Another way to describe extremes of height is the *height age*, the age at which the standard (median) height equals the child's present height. A 30 month old child who is as tall as an average 13 months old has height age of 13 months. The *weight age* is defined analogously .

Table 1: Severity of Malnutrition: Stunting and Wasting

Grade of Malnutrition	***Weight for Age[7] (Wasting)***	***Height for Age[8] (Stunting)***	***Weight for Height[9]***
0, normal	>90	>95	>90
1, mild	75-90	90-95	81-90
2,moderate	60-74	85-89	70-80
3, severe	<60	<85	<70

Values represent percentage of median for age.

Growth charts can confirm an impression of obesity if the weight for height exceeds 120% of the standard (median) weight for height. The body mass index (BMI) can be calculated as weight per height^2 when weight is in kilograms and height is in meters. According to the CDC, a BMI over the 95th percentile indicates "overweight", between 85th and 95th percentile is "risk of overweight", and below the 5th percentile is "underweight" [(6)]. Although widely accepted as the best clinical measure of under and over weight, BMI may not provide an accurate index of

adiposity, because it does not differentiate lean tissue and bone from fat. Measurement of triceps and subscapular skinfold thickness give a better estimate of adiposity, although considerable experience is needed for accuracy, and variability in fat distribution may confound the measurement.

PHYSICAL DEVELOPMENT

THE FIRST YEAR

During the first year of life, the physical growth, maturation, acquisition of competence, and psychological reorganization occur in discontinuous bursts. These changes qualitatively change a child's behavior and social relationships. Children acquire new competences in the gross motor, fine motor, cognitive, and emotional domains. The concept of developmental lines highlights how more complex skills build on simpler ones; but it is also important to realize how development in each domain affects functioning in all of the others.

AGE 0-2 MONTHS

The biologic and psychologic challenges facing neonates and their parents consist of establishing effective feeding routine

and predictable sleep-wake cycle. The social interaction that occurs as parents and infants accomplish these tasks lay the foundation for cognitive and emotional development[4].

A newborn's weight may decrease 10% below birth weight in the 1st week as a result of excess extravascular fluid and possibly poor intake. Intake improves as colostrums is replaced by higher-fat milk, as infants learn to latch on and suck more efficiently, and as mothers become more comfortable with feeding techniques. Infants should regain or exceed birthweight by 2 week of age and should grow at approximately 30 g(1oz)/day during the 1st month[4]. Limb movements consist largely of uncontrolled writhing, with apparently purposeless hand opening and closing. Smiling occurs involuntarily. In contrast, eye gaze, head turning, and sucking are under better control and thus can be used to demonstrate infant perception and cognition. For example, an infant's preferential turning toward the mother's voice is evidence of recognition memory.

AGE 2 – 6 MONTHS

At about 2 months, the emergence of voluntary (social) smiles and increasing eye contact mark a change in the parent-child relationship, heightening the parent's sense of being loved back.

Between 3 and 4 months, the rate of growth slows approximately 20 g/day [(4)]. Early reflexes that limited the voluntary movement recede. Disappearance of the asymmetric tonic neck reflex means that infants can begin to examine objects in the midline and manipulate them with both hands.

AGE 6-12 MONTHS

Months 6-12 bring increased mobility and exploration of the inanimate world, advances in cognitive understanding and communicative competence, and new tensions around the themes of attachment and separation. Infants develop will and intentions, characteristics that most parents welcome but still find challenging to manage. In this age group Growth slows more.

THE SECOND YEAR

AGE 12-18 MONTHS

Growth rate slows further in the 2nd year of life and appetite declines. "Baby fat" is burned up by increased mobility; exaggerated lumbar lordosis makes the abdomen protrude. Brain growth continues, with myelination throughout the 2nd year [5].

Most children begin to walk independently near their first birthday; some do not walk until 15 months. Highly active, fearless infants tend to walk earlier; less active, more timid infants and those who are preoccupied with exploring objects in detail walk later. Early walking is not associated with advanced development in other domains.

AGE 18 – 24 MONTHS

Motor development is incremental at this age, with improvements in balance and agility and the emergence of running and stair climbing. Height and weight increases at a steady rate, although head growth slows slightly.

ASSESSMENT OF GROWTH

Growth can be measured in terms of:

1. *Nutritional anthropometry* (weight, height, circumference of head, chest, abdomen and pelvis).
2. *Assessment of tissue growth* (skin fold thickness and measurement of muscle mass)
3. *Bone age* (radiological - by appearance and fusion of the various epiphyseal centers).
4. *Dental age*
5. *Biochemical and histological means.*

For day- to- day work anthropometry is the simplest tool.

NUTRITIONAL ANTHROPOMETRY

This is the technique of measuring somatic growth.

LENGTH

Until 24 or 36 months of age, length in recumbency is measured using an infantometer. The length is recorded in centimeters upto one decimal point [22].

WEIGHT

It is the commonest and important anthropometric measurement. The weighing scales best suited are those which are designed on balance arm principle. Accuracy up to 0.1 Kg is quite acceptable. For smaller babies machine of more accuracy is required as 0.1 Kg forms a higher percentage of total body weight. More recently, many electronic weighing scales giving accuracy of 0.01 Kg have been made available [22].

Weighing scales should be checked for accuracy using known weight from time to time. The beam scales are better instruments for all purposes rather than spring weighing scales, i.e. bathroom scales, as the spring may get expanded due to repeated use, may get rusted and variation of temperature may give false reading.

HEAD CIRCUMFERENCE

Head circumference is measured from the supraorbital ridge in front to the farthest point of the occiput in back. Cloth tapes stretch should be avoided. It should be recorded to the nearest 0.1 cm[22].

CHEST CIRCUMFERENCE

At birth, the head circumference is more than chest circumference and it equalizes by 1 year. Thereafter, the chest circumference is more than the head circumference. The chest circumference is measured at the nipple, midway between inspiration and expiration. In malnutrition, chest circumference will be less than head circumference[22].

AGE INDEPENDENT ANTHROPOMETRY

MID ARM CIRCUMFERENCE (MAC)

As the midarm circumference is relatively constant between 16.5 cm to 17.5 cm in 1 to 5 years of age, this measurement may be considered as an age independent variable up to 5 years of age. Any child whose MAC is less than 12.5 cm up to 5 years of age is considered malnourished [22]. Shakir's tape also measures the MAC.

WEIGHT FOR HEIGHT

The degree of wasting can be measured by comparing the child's weight with expected weight for a healthy child of the same height. Combinations of these measurements have been used to distinguish different types of malnutrition.

GROWTH VELOCITY

Growth velocity (the height velocity) is the rate of growth over a fixed time interval. The velocity must oscillate closer to the 50^{th} centile (velocity if $<3^{rd}$ centile – slowing; $> 90^{th}$ centile rapid increase – both are abnormal). A velocity change is the earliest evidence of alteration in growth rate as compared to "distance growth curve". Thus, a doctor can suspect disease / nutritional deprivation / behavioral problem if velocity falls.

REVIEW OF LITERATURE

Agarwal DK, Agarwal KN. Physical growth in Indian affluent children (Birth -6 years). Indian Pediatr 1994; 31:377-413.

1. They measured growth characteristics viz., height, weight & circumference of head, chest and midarm in urban affluent children from seven centers (Bangalore, Calcutta, Delhi, Kota, Ludhiana & Varanasi – Nutrition foundation of India Study)

2. They observed values lower than European and NCHS Standards.

3. They concluded that the difference in growth seem to be possibly due to lower velocity in Indian children in the first 18 month as compared to American children.

Official 2000 centers for disease control (CDC) growth charts & percentile charts by NCHS.

1. It was constructed from data accumulated from USA. It may not represent children from developing countries.

2. There is no certainty that the growth of NCHS data base is optimal – they may well be too fat; and bigger is not necessarily better.

3. In most of the developing countries growth failure in children is widespread and severe. Estimates of

malnutrition on the basis of NCHS reference would, therefore, “overestimate” the true extent of the problem.

4. Health planners may find targets based on NCHS standards unrealistic and unattainable;

WORLD HEALTH ORGANIZATION. A growth chart for international use in maternal and child health care. Geneva, 1978

1. WHO growth chart for international use was developed by reviewing the charts from various regions from both developed and developing countries.

2. The interpretation of weight curve on the service chart must be made in relation to five reference lines on the weight grid. The channels formed by those lines were labeled with the letters A, B, C, D, E, F for purposes of identification nutritional status of the children. It proposes that each country should decide form existing local data , which of these channels best represents the current status of most of the population.

3. In this report WHO opines that countries or regions might eventually develop local reference standards; in the interim these reference lines should provide an effective substitute.

STUDY JUSTIFICATION

The growth chart offers a simple and inexpensive means of monitoring child health and nutritional status in local health services and can be utilized with minimal instruction and supervision. The chart represents a convenient means of organizing and presenting basic health data and permits the assessment of current status as well as the observation of trends in growth performance. It facilitates the classification of nutritional status and thus provides an objective basis for decision-making in relation to care. The precise criteria that are used to interpret growth chart data and to define the levels of care required must, however, be determined on the basis of local needs, resources and service patterns.

It is clear that local reference standards should be utilized for the purpose of comparison. Arguments in favor of local reference include: (i) There is no certainty that the growth of NCHS data base is optimal – they may well be too fat; and bigger is not necessarily better; (ii) Use of a local standard will provide a picture of the average in a country in order to identify groups or individuals who are above or below the average. It is felt that selection of malnourished children by anthropometric variables can only be

done successfully by “local references” which represent “acceptable growth in a given environment”. (iii) In most of the developing countries, growth failure in children is widespread and severe. Estimates of malnutrition on the basis of NCHS reference would, therefore, “overestimate” the true extent of the problem. Similarly, planners may find targets based on NCHS standards unrealistic and unattainable; and (iv) For the purpose of comparisons between populations, a reference may not really be necessary .

Many developing countries are experiencing secular trends of increasing weight and height, making it necessary to update local population – average references after several years.

This study was planned with the aim of constructing reference standards for anthropometric measurements for our population

SUBJECTS AND METHODS

- **STUDY DESIGN:** Prospective cross sectional survey
- **PLACE OF STUDY:** Institute of child health and Hospital for Children, Egmore, chennai-8
- **STUDY PERIOD**: March 2005 - October 2006.
- **STUDY POPULATION**:
  - Inclusion Criteria:
    - 0-2yrs children.
    - Children attending well baby clinics and immunization clinics for follow up and immunization.
    - Children attending out patient departments of government hospitals and private nursing homes with milder ailments like upper respiratory infections.
    - Children attending cretches.
    - Those with valid date of birth
  - **Exclusion criteria:**
    - Children with systemic illness and/or any significant illness in recent past
    - Very low birth wt infants.

❖ **SAMPLE SIZE:**

- By analyzing previous studies, demography of Chennai corporation and in consultation with statistician , at each age and sex point-100 observations will be taken
- Total sample size:-1400

SAMPLING TECHNIQUE :

- Stratified random sampling

MANEUVER:

Sample were selected from those attending well baby clinics and immunization clinics for follow up and immunization, from out patient departments of government hospitals and private nursing homes with milder ailments like upper respiratory infections and those attending cretches. Their date of birth was confirmed from their birth records.

Those children whose age corresponds with the various age points selected for this study were included. Informed consent from parents was obtained. Their various anthropometric measurements (Weight, Length, Head circumference, Chest circumference, Mid arm circumference) were measured accurately.

HEIGHT MEASUREMENT

Infant are measured lying on its back over the infantometer. One person holds the infant's head with the line of sight vertical and gently ensures that the top of its head is in contact with the fixed headboard. A second person holds the knees flat, moves the sliding board firmly against the feet, and reads the value from the scale. Readings are measured with an accuracy upto 0.1 cm.

WEIGHT MEASUREMENT

The weight is measured using a beam scale with an accuracy up to 0.1 Kg. For new born babies electronic weighing machine with accuracy upto 0.01Kg is used. Weighing scales are checked and calibrated for accuracy using known weight from time to time. Babies are weighed without clothes or clothed only in lightweight panties.

HEAD CIRCUMFERENCE

Head circumference was measured from the supraorbital ridge in front to the farthest point of the occiput in back with a non-stretchable tape to the nearest 0.1 cm.

CHEST CIRCUMFERENCE

The chest circumference was measured at the nipple midway between inspiration and expiration using a non-stretchable tape to the nearest 0.1 cm.

MID ARM CIRCUMFERENCE (MAC)

The midarm circumference was measured mid way between acromion and olecranon process using a non-stretchable tape to the nearest 0.1 cm.

STATISTICAL ANALYSIS:

All results were tabulated and percentage was arrived by using windows MS Excel application and analysis was performed by using SPSS version 11.0-Software. Descriptive statistics like frequencies and percentages were obtained.

RESULTS

Samples were tabulated age wise, sex wise. Results were also tabulated according to various anthropometric measurements in both sexes.

No of children enrolled: -

Total -1400

Male- 700

Female-700

LENGTH FOR AGE:

The percentile chart of length for age for boys and girls are presented in the table – 2 & 3.

The 50^{th} percentile and mean value of length for age in boys were marginally higher than for girls. This was also true at 3^{rd} and 97^{th} percentile.

At birth for boys the 50^{th} percentile length is 50 cm and the 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 47, 47.5, 52.8 and 52.9 cm respectively. For girls at this age group the 50^{th} percentile length is 63 cm and 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 47, 47.5, 52.8 and 53 cm respectively.

At 3 months age for boys the 50th percentile length is 63 cm and the 3rd, 5th, 95th, and 97th percentile were 57.4, 58.7, 67 and 68.3 cm respectively. For girls at this age group the 50th percentile length is 61.2 cm and 3rd, 5th, 95th, and 97th percentile were 57.5, 58, 65.2 and 65.2 cm respectively

At 6 months age for boys the 50th percentile length is 68.3 cm and the 3rd, 5th, 95th, and 97th percentile were 61.5, 61.5, 73 and 73.2 cm respectively. For girls at this age group the 50th percentile length is 67 cm and 3rd, 5th, 95th, and 97th percentile were 63.1, 63.7, 70.3 and 71 cm respectively

At 9 months age for boys the 50th percentile length is 71.2 cm and the 3rd, 5th, 95th, and 97th percentile were 67.5, 68.1, 75.4 and 75.9 cm respectively. For girls at this age group the 50th percentile length is 71 cm and 3rd, 5th, 95th, and 97th percentile were 65, 65.5, 74.7 and 75.5 cm respectively

At 12 months age for boys the 50th percentile length is 74.5 cm and the 3rd, 5th, 95th, and 97th percentile were 70, 70, 79 and 82.1 cm respectively. For girls at this age group the 50th percentile length is 73.5 cm and 3rd, 5th, 95th, and 97th percentile were 68, 68.5, 77.5 and 78 cm respectively

At 18 months age for boys the 50th percentile length is 79.4 cm and the 3rd, 5th, 95th, and 97th percentile were 74, 75, 85.1 and 85.6 cm respectively. For girls at this age group the 50th percentile length is 79 cm and 3rd, 5th, 95th, and 97th percentile were 72.2, 73, 83.5 and 84.5 cm respectively

At 24 months age for boys the 50th percentile length is 85.7 cm and the 3rd, 5th, 95th, and 97th percentile were 78, 79.9, 91 and 91.5 cm respectively. For girls at this age group the 50th percentile length is 84.3 cm and 3rd, 5th, 95th, and 97th percentile were 76.5, 77.1, 90 and 90.9 cm respectively

TABLE - 2

Percentile for Length (Cm.) of Boys from birth to 2 yrs

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	47	47.5	48	48.9	49.1	49.5	49.8	50.0 (50.0)	50.2	50.8	51	51.2	52	52.8	52.9
3	57.4	58.7	59.2	60.8	61.3	61.7	62.3	63 (62.9)	63.6	64.4	65	65.2	66	67	68.3
6	61.5	61.5	61.9	65.7	66.6	66.8	67.6	68.3 (68.3)	69.2	70.8	71	71.5	72.5	73	73.2
9	67.5	68.1	68.9	69.3	69.6	70.1	70.6	71.2 (72)	71.6	72	73	73.4	74.6	75.4	75.9
12	70.0	70.0	70.5	72.3	73	73.4	74	74.5 (74.6)	75.3	76.0	76.1	76.5	78	79	82.1
18	74	75	75	76	76	77	78	79.4 (79.6)	80.7	82	83	83	85	85.1	85.6
24	78	79.9	80.6	83	83.6	84	85	85.7 (85.3)	86	87	87.5	87.6	89	91	91.5

TABLE - 3

Percentile for Length (Cm.) of Girls from birth to 2 yrs

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	47	47.5	48.4	49	49.1	49.3	49.8	50.2 (50.3)	50.6	51.1	51.3	52	52.5	52.8	53
3	57.5	58	58.3	59	59.3	59.9	60.5	61.2 (61.2)	62.1	62.5	62.6	63.1	64.4	65.2	65.2
6	63.1	63.7	64.8	65.7	65.9	66	66.4	67.0 (67.2)	68	68.7	68.9	69.1	69.6	70.3	71
9	65.0	65.5	67.1	68.8	69.5	70.2	70.8	71.0 (71.2)	71.5	72.0	72.5	72.7	73.3	74.7	75.5
12	68	68.5	69.6	71.1	71.8	72	73	73.5 (73.4)	74	75	75.5	76.1	77	77.5	78
18	72.2	73	74	75.3	76	76.7	78	79.0 (78.5)	80	80.4	81	81.2	83	83.5	84.5
24	76.5	77.1	79	80.6	82	81.5	83.2	84.3 (84.0)	85	86	86.8	87	89	90	90.9

WEIGHT FOR AGE:

The percentile chart of weight for age for boys and girls are presented in the table – 4 & 5.

Boys have marginally higher weight at all age points than girls.

At birth for boys the 50^{th} percentile weight is 3 Kg and the 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 2.3, 2.4, 3.9 and 4 Kg respectively. For girls at this age group the 50^{th} percentile weight is 3.1 Kg and 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 2.4, 2.5, 3.9 and 4 Kg respectively

At 3 months age for boys the 50^{th} percentile weight is 5.8 Kg and the 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 4, 4.3, 7.1 and 7.3 Kg respectively. For girls at this age group the 50^{th} percentile weight is 5.4 Kg and 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 4.3, 4.3, 7 and 7.2 Kg respectively

At 6 months age for boys the 50^{th} percentile weight is 7.2 Kg and the 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 5.4, 5.5, 8.5 and 9.3 Kg respectively. For girls at this age group the 50^{th} percentile weight is 7.1 Kg and 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 5.5, 5.5, 8.5 and 8.5 Kg respectively

At 9 months age for boys the 50th percentile weight is 8.5 Kg and the 3rd, 5th, 95th, and 97th percentile were 6.5, 6.8, 10 and 10.5 Kg respectively. For girls at this age group the 50th percentile weight is 7.9 Kg and 3rd, 5th, 95th, and 97th percentile were 6.0, 6.1, 9.5 and 9.5 Kg respectively

At 12 months age for boys the 50th percentile weight is 9.3 Kg and the 3rd, 5th, 95th, and 97th percentile were 7.0, 7.2, 11.0 and 11.5 Kg respectively. For girls at this age group the 50th percentile weight is 8.8 Kg and 3rd, 5th, 95th, and 97th percentile were 7, 7, 10.5 and 11 Kg respectively

At 18 months age for boys the 50th percentile weight is 10 Kg and the 3rd, 5th, 95th, and 97th percentile were 8, 8, 13 and 14 Kg respectively. For girls at this age group the 50th percentile weight is 10 Kg and 3rd, 5th, 95th, and 97th percentile were 7.5, 7.5, 11.9 and 12 Kg respectively

At 24 months age for boys the 50th percentile weight is 11.7 Kg and the 3rd, 5th, 95th, and 97th percentile were 8.5, 9, 14 and 14.2 Kg respectively. For girls at this age group the 50th percentile weight is 11.2 Kg and 3rd, 5th, 95th, and 97th percentile were 8, 9, 13.6 and 14 Kg respectively

TABLE - 4

Percentile for Weight (Kg.) of Boys from birth to 2 years.

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0 (3.1)	3.1	3.1	3.4	3.5	3.7	3.9	4
3	4	4.3	4.7	5.2	5.3	5.5	5.7	5.8 (5.8)	6	6.2	6.3	6.4	6.8	7.1	7.3
6	5.4	5.5	5.8	6.3	6.5	6.7	6.8	7.2 (7.2)	7.8	8	8.1	8.2	8.5	8.5	9.3
9	6.5	6.8	7	7.3	7.5	7.7	8.3	8.5 (8.4)	8.7	8.8	9	9.3	9.8	10	10.5
12	7.0	7.2	7.5	8.4	8.7	8.8	9.0	9.3 (9.2)	9.5	9.9	10.0	10.0	10.7	11.0	11.5
18	8	8	8	8.9	9	9	9.5	10.0 (10.0)	10	11	11	11	12	13	14
24	8.5	9	9.9	10.6	11	11.1	11.4	11.7 (11.6)	12	12.2	12.4	12.6	13.3	14	14.2

TABLE - 5

Percentile for Weight (Kg.) of Girls from birth to 2 years

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	2.4	2.5	2.6	2.8	2.8	2.9	3.0	3.1 (3.2)	3.2	3.4	3.5	3.6	3.8	3.9	4.0
3	4.3	4.3	4.5	4.7	4.8	4.9	5.3	5.4 (5.4)	5.5	5.8	6.0	6.1	6.5	7.0	7.2
6	5.5	5.5	6	6.3	6.5	6.5	6.7	7.1 (7.0)	7.3	7.4	7.5	7.5	7.8	8.5	8.5
9	6.0	6.1	6.5	7.0	7.3	7.5	7.8	7.9 (7.8)	8.0	8.3	8.3	8.4	8.9	9.5	9.5
12	7.0	7.0	7.5	8.0	8.3	8.5	8.5	8.8 (8.9)	9.0	9.3	9.4	9.7	10.3	10.5	11.0
18	7.5	7.5	8.0	8.7	9.0	9.0	9.5	10.0 (9.7)	10.0	10.5	10.7	10.8	11.2	11.9	12.0
24	8.0	9.0	9.0	10.0	10.5	10.6	11.0	11.2 (11.2)	11.5	12.0	12.0	12.4	13.0	13.6	14.0

HEAD CIRCUMFERENCE FOR AGE:

The percentile charts for head circumference for boys and girls are presented in the table – 6 & 7.

The 50^{th} percentiles of head circumference in boys were marginally higher than girls except at birth and 18 months.

At birth for boys the 50^{th} percentile head circumference is 34.6 cm and the 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 33, 33, 36.8 and 37cm respectively. For girls at this age group the 50^{th} percentile head circumference is 34.7 cm and 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 32.5, 33, 36.4 and 36.7 cm respectively.

At 3 months age for boys the 50^{th} percentile head circumference is 39.9 cm and the 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 37.3, 37.8, 42 and 42.6 cm respectively. For girls at this age group the 50^{th} percentile head circumference is 39.2 cm and 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 37, 37.1, 41.6 and 41.7 cm respectively

At 6 months age for boys the 50^{th} percentile head circumference is 42.4 cm and the 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 38.7, 39.1, 45.3 and 45.5 cm respectively. For girls at this age group the 50^{th} percentile head circumference is 41.5 cm and 3^{rd}, 5^{th}, 95^{th}, and 97^{th} percentile were 39.5, 39.6, 43.9 and 44.1 cm respectively

TABLE - 6

Percentile for Head Circumference (Cm.) of Boys from birth to 2 years

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	33	33	33.6	34	34.1	34.2	34.5	34.6 (34.7)	34.9	35.1	35.2	35.5	36.5	36.8	37
3	37.3	37.8	38.5	38.8	39	39.5	39.8	39.9 (39.8)	40	40.4	40.5	40.8	41.1	42	42.6
6	38.7	39.1	39.6	40.8	41	41.4	42	42.4 (42.2)	42.7	43	43.2	43.6	44.4	45.3	45.5
9	42	42	42.5	42.8	43	43.4	43.8	44.0 (44.1)	44.3	44.9	45.3	45.5	45.8	46.4	46.5
12	42.7	43	43.5	44.3	44.5	44.8	45.1	45.3 (45.4)	45.6	46	46.5	47	47.5	47.6	48
18	43.2	43.5	43.8	44.4	44.7	44.8	45.2	45.5 (45.8)	46	46.7	47	47.2	47.8	48.5	50.7
24	44.9	45	45.7	46.5	46.7	46.8	47	47.5 (47.5)	48	48.3	48.5	48.6	49	49.2	50

TABLE - 7

Percentile for Head Circumference (Cm.) of Girls from birth to 2 years

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	32.5	33	33.2	33.9	34	34.2	34.5	34.7 (34.7)	35	35.2	35.4	35.5	36	36.4	36.7
3	37	37.1	37.7	38.4	38.5	38.7	39	39.2 (39.4)	39.6	39.9	40.2	40.5	41.3	41.6	41.7
6	39.5	39.6	40.3	40.5	40.5	40.7	41.2	41.5 (41.8)	41.7	42.5	42.5	43.1	43.6	45	45.3
9	40.9	41.3	41.5	42.0	42.0	42.0	42.4	42.5 (42.7)	42.8	43.2	43.3	43.7	44.2	44.6	45.6
12	42	42.7	43.1	44	44	44.2	44.5	44.9 (44.7)	45	45.5	45.6	45.7	46	46.3	46.4
18	42.5	43.2	43.6	44.1	44.5	44.7	45.2	45.6 (45.5)	46	46.3	46.4	46.5	47	47.9	48
24	44	44.2	44.9	45.3	45.7	46	46.5	47.0 (46.8)	47.2	47.6	47.8	48	48.5	49	50

At 9 months age for boys the 50th percentile head circumference is 44 cm and the 3rd, 5th, 95th, and 97th percentile were 42, 42, 46.4 and 46.5 cm respectively. For girls at this age group the 50th percentile head circumference is 42.5 cm and 3rd, 5th, 95th, and 97th percentile were 40.9, 41.3, 44.6 and 45.6 cm respectively

At 12 months age for boys the 50th percentile head circumference is 45.3 cm and the 3rd, 5th, 95th, and 97th percentile were 42.7, 43, 47.6 and 48 cm respectively. For girls at this age group the 50th percentile head circumference is 44.9 cm and 3rd, 5th, 95th, and 97th percentile were 42, 42.7, 46.3 and 46.4 cm respectively

At 18 months age for boys the 50th percentile head circumference is 45.5 cm and the 3rd, 5th, 95th, and 97th percentile were 43.2, 43.5, 48.5 and 50.7 cm respectively. For girls at this age group the 50th percentile head circumference is 45.6 cm and 3rd, 5th, 95th, and 97th percentile were 42.5, 43.2, 47.9 and 48 cm respectively

At 24 months age for boys the 50th percentile head circumference is 47.5 cm and the 3rd, 5th, 95th, and 97th percentile were 44.9, 45, 49.2 and 50 cm respectively. For girls at this age

group the 50th percentile head circumference is 47 cm and 3rd, 5th, 95th, and 97th percentile were 44, 44.2, 49 and 50 cm respectively

CHEST CIRCUMFERENCE:-

The percentile charts for chest circumference for boys and girls are presented in the table – 8 & 9

The 50th percentiles of chest circumference in boys were marginally higher than girls except at birth and 18 months.

The 50th percentiles of head circumference in both boys and girls were higher than the 50th percentiles of chest circumference from birth to 12 months. The chest circumference equalized head circumference at 1 year and thereafter Chest circumference is more than the head circumference.

MIDARM CIRCUMFERENCE:

The percentile charts for mid arm circumference for boys and girls are presented in the table – 10 & 11.

The 50th percentiles values of mid arm circumference in boys and girls were similar with only marginal difference

The maximum increment in mid arm circumference appear to be in the first 9 months of age. Thereafter, the increments were smaller.

TABLE - 8

Percentile for Chest Circumference (Cm.) of Boys from birth to 2 years

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	30	30	31	31.4	31.5	31.6	32	32.1 (32.4)	32.5	33	33.4	33.6	34	34.9	35
3	35.9	36.5	37	37.5	37.7	37.9	38.5	39.0 (39.2)	39.7	40.3	40.5	40.7	42.1	42.7	43.4
6	38.2	38.2	39.5	39.7	39.9	40.3	41	41.2 (41.5)	41.7	42.4	42.5	43.1	44.6	45.4	45.4
9	40.1	40.2	40.4	41	41.7	42	42.4	43.5 (43.2)	44	44.5	44.6	44.8	45.2	46.5	46.7
12	41.8	42	42.5	44	44.2	44.4	45	45.4 (45.4)	45.9	46.1	46.5	46.7	48	49.5	50
18	43.2	43.4	44	44.9	45	45	45.5	46.0 (46.3)	46.5	47	47.5	47.8	49.3	50.5	51
24	44.8	45	46	47	47.5	47.8	48.4	48.9 (48.7)	49	49.5	50	50.1	51.8	52	52.5

TABLE - 9

Percentile for Chest Circumference (Cm.) of Girls from birth to 2 years

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	30.1	30.2	30.5	31.7	31.8	31.9	32.2	32.5 (32.6)	32.7	33.4	33.5	33.8	34.2	34.8	35
3	35.5	35.5	36.1	37.2	37.4	37.6	38.3	38.5 (38.7)	38.9	39.5	39.8	40	42	42.8	44
6	37.8	37.8	39.1	39.7	40.1	40.1	40.5	40.7 (41.0)	41	41.6	42.2	42.5	43.5	44.9	45.2
9	39.6	40.0	40.0	41.0	40.2	40.5	40.9	42.3 (42.3)	42.8	43.0	43.4	43.5	44.0	44.8	45.7
12	41.6	42	43	43.5	44	44	44.5	44.7 (44.8)	45	45	45.5	45.6	47.9	48	48.7
18	42.5	42.9	43.6	44.3	45	45.4	46	46.4 (46.2)	46.7	47	47.4	47.6	48.6	49.5	49.9
24	42.6	44	44.7	45.8	46.7	47	47.5	48 (47.8)	48.4	49	49	49.4	50.1	52	53

TABLE - 10

Percentile for MAC (Cm.) of Boys from birth to 2 years

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	8.1	8.5	9	9.1	9.1	9.2	9.5	9.6 (9.8)	10	10.2	10.3	10.6	11	11.4	11.9
3	11.1	11.4	11.7	12	12.1	12.3	12.5	12.8 (12.9)	13.1	13.6	13.7	14	14.5	14.5	14.6
6	11.6	11.9	12.4	12.7	12.9	13.0	13.2	13.5 (13.6)	13.7	14.2	14.3	14.5	14.7	15.4	15.5
9	11.8	11.9	12.3	12.9	13.4	13.5	14.0	14.2 (14.0)	14.6	14.7	15.0	15.0	15.3	15.7	15.7
12	12.1	12.3	12.5	13.2	13.2	13.5	14.0	14.5 (14.2)	14.6	15.0	15.0	15.1	15.5	16.3	16.5
18	12.5	12.5	13.2	13.7	13.9	14.4	14.5	14.6 (14.6)	15.0	15.2	15.4	15.5	15.9	16.4	16.6
24	13	13.1	13.5	14.2	14.5	14.5	14.6	14.7 (14.9)	15	15.6	15.8	15.9	16.2	16.5	16.7

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TABLE - 11

Percentile for MAC (Cm.) of Girls from birth to 2 years

Age (Months)	Percentile														
	3rd	5th	10th	20th	25th	30th	40th	50th	60th	70th	75th	80th	90th	95th	97th
Birth	8.5	8.8	9.1	9.3	9.3	9.4	9.6	9.8 (9.9)	9.9	10.2	10.3	10.5	11.1	11.3	11.5
3	11.1	11.2	11.5	11.7	11.9	12	12.4	12.6 (12.6)	13	13.2	13.3	13.3	13.7	14	14.6
6	11.7	11.7	11.7	12.5	12.5	12.8	13.2	13.5 (13.4)	13.5	14.0	14.3	14.5	15	15	15
9	11.8	12.0	12.4	12.7	13.0	13.1	13.5	13.6 (13.6)	13.7	14.0	14. 3	14.5	15.4	15.6	15.7
12	11.9	12.0	12.3	12.7	13.0	13.0	13.4	14.0 (13.9)	14.3	14.6	14.9	15.0	15.5	16.0	16.0
18	12	12.1	12.7	13.4	13.5	13.5	13.8	14.3 (14.2)	14.6	14.8	14.9	15.1	15.6	16.5	16.5
24	12.6	12.9	13.2	13.7	14	14.1	14.5	14.6 (14.8)	15.0	15.5	15.9	16	16.8	17.4	17.5

TABLE – 12

Percentage of children whose weight below 5^{th} percentile & above 95^{th} percentile according to NCHS standards

Age	Weight							
	<5th percentile				>95th percentile			
	Boys		Girls		Boys		Girls	
	n	%	n	%	n	%	n	%
Birth	0	0.0	9	9.0	0	0.0	1	1.0
3	18	18.0	20	20.0	0	0.0	3	3.0
6	33	33.0	15	15.0	0	0.0	0	0.0
9	31	31.0	21	21.0	2	2.0	0	0.0
12	27	27.0	21	21.0	0	0.0	0	0.0
18	48	48.0	35	35.0	1	1.0	0	0.0
24	20	20.0	23	23.0	0	0.0	0	0.0

When NCHS percentile charts[1] were applied to our population 9% of girls at birth, 18% of boys at 3 months, 20% of girls at 3 months, 33% of boys at 6 months and 15% of girls at 6 months, 31% of boys at 9 months, 21% of girls at 9 months, 27% of boys at 12 months, 21% of girls at 12 months, 48% of boys at 18 months, 35% of girls at 18 months, 20% of boys at 24 months and 23% of girls at 24 months were below 5^{th} percentile i.e. undernourished according to their standards !!.

TABLE – 13

Percentage of children whose height below 5^{th} percentile & above 95^{th} percentile According to NCHS standards

Age	Length							
	<5th percentile				>95th percentile			
	Boys		Girls		Boys		Girls	
	n	%	n	%	n	%	n	%
Birth	95	95.0	79	79	0	0	0	0
3	65	65.0	54	54	0	0	0	0
6	46	46.0	25	25	0	0	0	0
9	22	22.0	23	23	0	0	0	0
12	86	86.0	75	75	0	0	0	0
18	62	62.0	70	70	0	0	0	0
24	61	61.0	54	54	0	0	0	0

When NCHS percentile charts[(1)] were applied to our population 95% of boys at birth, 79% of girls at birth, 65% of boys at 3 months, 54% of girls at 3 months, 46% of boys at 6 months and 25% of girls at 6 months, 22% of boys at 9 months, 23% of girls at 9 months, 86% of boys at 12 months, 75% of girls at 12 months, 62% of boys at 18 months, 70% of girls at 18 months, 61% of boys at 24 months and 54% of girls at 24 months were below 5^{th} percentile i.e. stunted according to their standards !

TABLE:-14

Comparison of Height (cm) of NCHS[1] , Agarwal[2] & Present study

Study		*Birth*	*3 mon*	*6 mon*	*9 mon*	*12mon*	*18mon*	*24mon*
NCHS[1]	Boys	56.6	67.9	72.3	76.1	82.4	87.7	92.1
	Girls	55.3	66.1	70.6	74.4	80.8	86.2	91.1
Agarwal[2]	Boys	50.4	59.4	65.9	70.6	74.3	80.7	86.0
	Girls	50.3	59.1	65.5	70.0	73.5	79.8	85.0
Present Study	Boys	50.0	63.0	68.3	71.2	74.5	79.4	85.7
	Girls	50.2	61.2	67.0	71.0	73.5	79.0	84.3

Table 14 shows Comparison of Height (cm) of NCHS[1], Agarwal[2] & Present study. The 50 th percentile height values of this study is comparable with study by Agarwal et al[2] , where as they are 3-6 cm less when compared to NCHS [1].

TABLE:-15

Comparison of Weight(Kg) of NCHS [1] , Agarwal [2] & Present study

Study		*Birth*	*3 mon*	*6 mon*	*9 mon*	*12mon*	*18mon*	*24mon*
NCHS[1]	Boys	3.53	6.39	8.16	9.48	10.46	11.80	12.74
	Girls	3.40	5.86	7.45	8.69	9.67	11.09	12.13
Agarwal[2]	Boys	3.10	5.70	7.40	8.50	9.30	10.70	11.9
	Girls	3.20	5.40	7.00	8.10	9.00	10.40	11.6
Present Study	Boys	3.00	5.80	7.20	8.50	9.30	10.00	11.7
	Girls	3.10	5.40	7.10	7.90	8.80	10.00	11.2

Table 14 shows Comparison of Weight(Kg) of NCHS[1] , Agarwal [2] & Present study. The 50 th percentile weight values of this study is comparable with study by Aarwal et al[2], where as they are 0.5-1.2 Kg less when compared to NCHS [1].

TABLE:-16

Comparison of Head circumference of NCHS[1], European & Present study

Author/Study	*Country*		*Birth*	*3*	*6*	*9*	*12*	*18*	*24*
Roede & Van [16]	Netherlands	Mean		39.7	42.8	45.6	45.9		
Hernandez et al.1985[17]	Spain	Median	34.0	40.1	42.8	44.7	46.0	47.3	
Kurniewicz-Witczakowa et al.1983 [18]	Poland	Mean	34.3	40.1	43.2	45.3	46.3	47.3	
NCHS [1]	USA	Boys	35.8	41.8	44.0	45.5	46.5	47.9	48.7
		Girls	34.7	40.5	42.7	44.2	45.2	46.6	47.5
Present study	India	Boys	34.6	39.9	42.4	44.0	45.3	45.5	47.5
		Girls	34.7	39.2	41.5	42.5	44.9	45.6	47.0

Table-16 shows the comparison of Head Circumference of NCHS[1], European & Present study. The 50th percentile Head Circumference values for Boys & Girls of the present study is 1-2 cm less when compared with NCHS[1].

TABLE:-17

Comparison of Chest circumference of European, & Agarwal [2] & Present study

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Author/Study	*Country*		*Birth*	*3*	*6*	*9*	*12*	*18*	*24*
Kurniewicz-Witczakowa et al.1983 [18]	Poland	Mean	32.9	41.0	44.6	46.7	47.4	48.1	
Agarwal et al 1994 [2]	India	Boys	32.6	38.4	42.0	44.1	45.4	47.4	49.0
		Girls	32.4	38.0	41.6	43.7	45.0	46.9	48.4
Present study	India	Boys	32.1	39.0	41.2	43.5	45.4	46.0	48.9
		Girls	32.5	38.5	40.7	42.3	44.7	46.4	48.0

Table-17 shows the comparison of Head Circumference of European, Agarwal [2] & Present study. The 50th percentile Head Circumference values for Boys & Girls of the present study is comparable with Agarwal et al [2] except for 0.5 -1 cm difference at certain age points. When compared to European study the values were 1-2 cm less at various age points.

TABLE:-18

Comparison of Mid Arm circumference of European, Agarwal [2] & Present study.

Author/Study	*Country*		*Birth*	*3*	*6*	*9*	*12*	*18*	*24*
Kurniewicz-Witczakowa et al.1983 [18]	Poland	Mean					16.0		16.5
Hernandez et al.1985 [17]	Spain	Mean					16.0		16.3
Agarwal et al 1994 [2]	India	Boys	9.8	12.3	13.7	14.3	14.5	15.1	15.0
		Girls	9.9	12.2	13.5	14.1	14.3	14.7	15.0
Present study	India	Boys	9.6	12.8	13.5	14.2	14,5	14.6	14.7
		Girls	9.8	12.6	13.5	13.6	14.0	14.3	14.6

Table-18 shows the comparison of Mid Arm Circumference of European, Agarwal [2] & Present study. The 50th percentile Head Circumference values for Boys & Girls of the present study is comparable with Agarwal et al [2] except . When compared to European study the values were 2-2.5 cm less at 12 and 24 months age point.

Figure-1

Comparison of Height (cm) of Boys between NCHS [(1)] & Present study

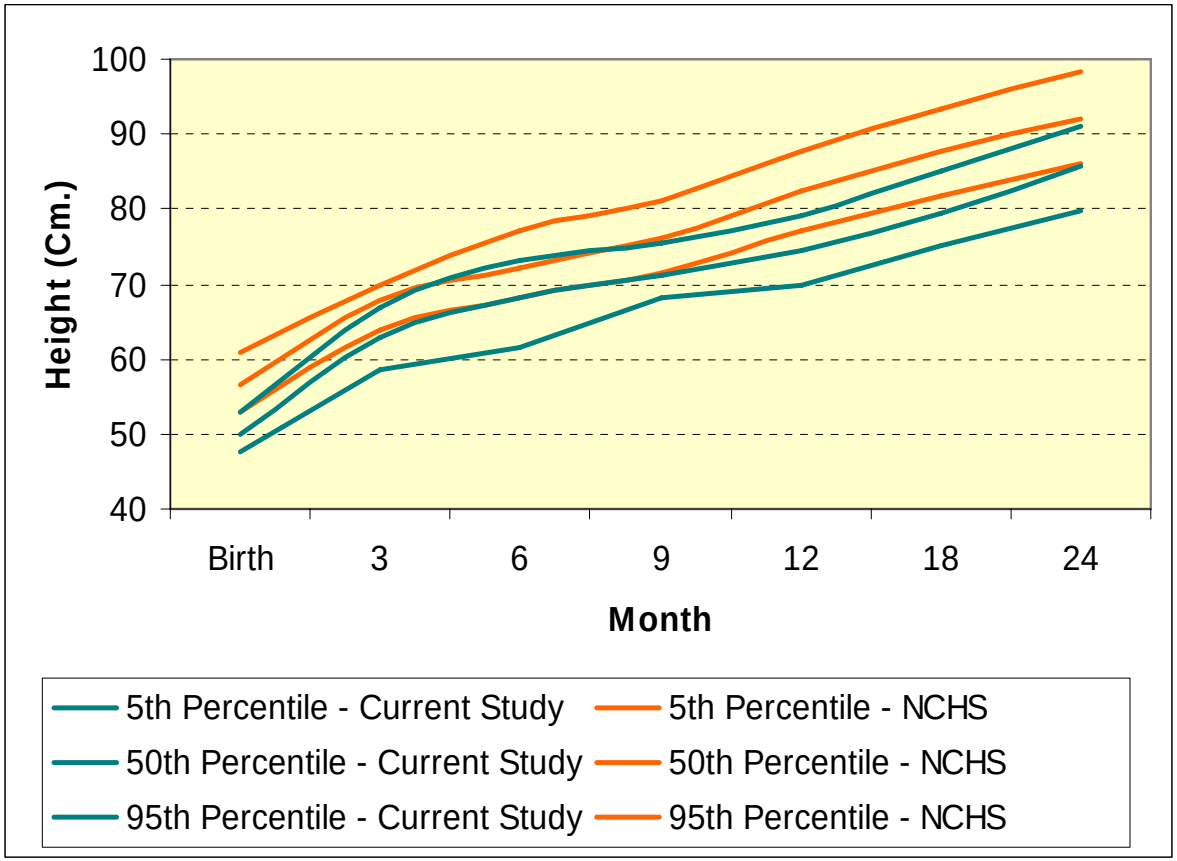

Figure-1 shows Comparison of Height (cm) of Boys between NCHS [1], & Present study. The figure shows the 5th, 50th, 95th percentile height values of this study compared with NCHS.

The 50th percentile line for Boys of this study fall below the 5th percentile line of the NCHS growth chart [1]. Similarly the 95th percentile line of this study fall below the 50th percentile line of the NCHS growth chart [1].

Figure-2 shows Comparison of Height (cm) of Girls between NCHS [1], & Present study. The figure shows the 5th, 50th, 95th percentile height values of this study compared with NCHS [1].

The 50th percentile line for Girls of this study fall below the 5th percentile line of the NCHS growth chart [1]. Similarly the 95th percentile line of this study fall below the 50th percentile line of the NCHS growth chart [1].

Figure-2

Comparison of Height (cm) of Girls between NCHS[(1)] & Present study

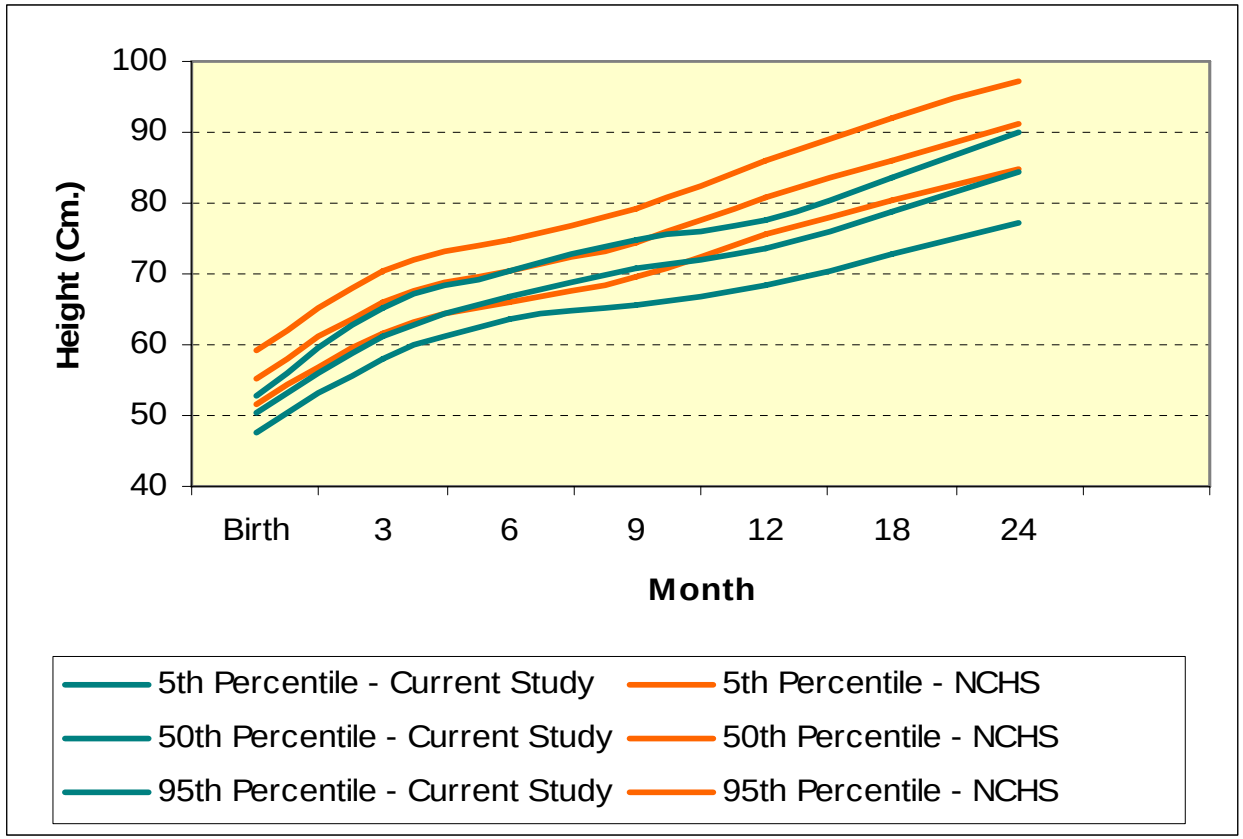

Figure-3

Comparison of Weight (Kg) of Boys between NCHS [1] & Present study

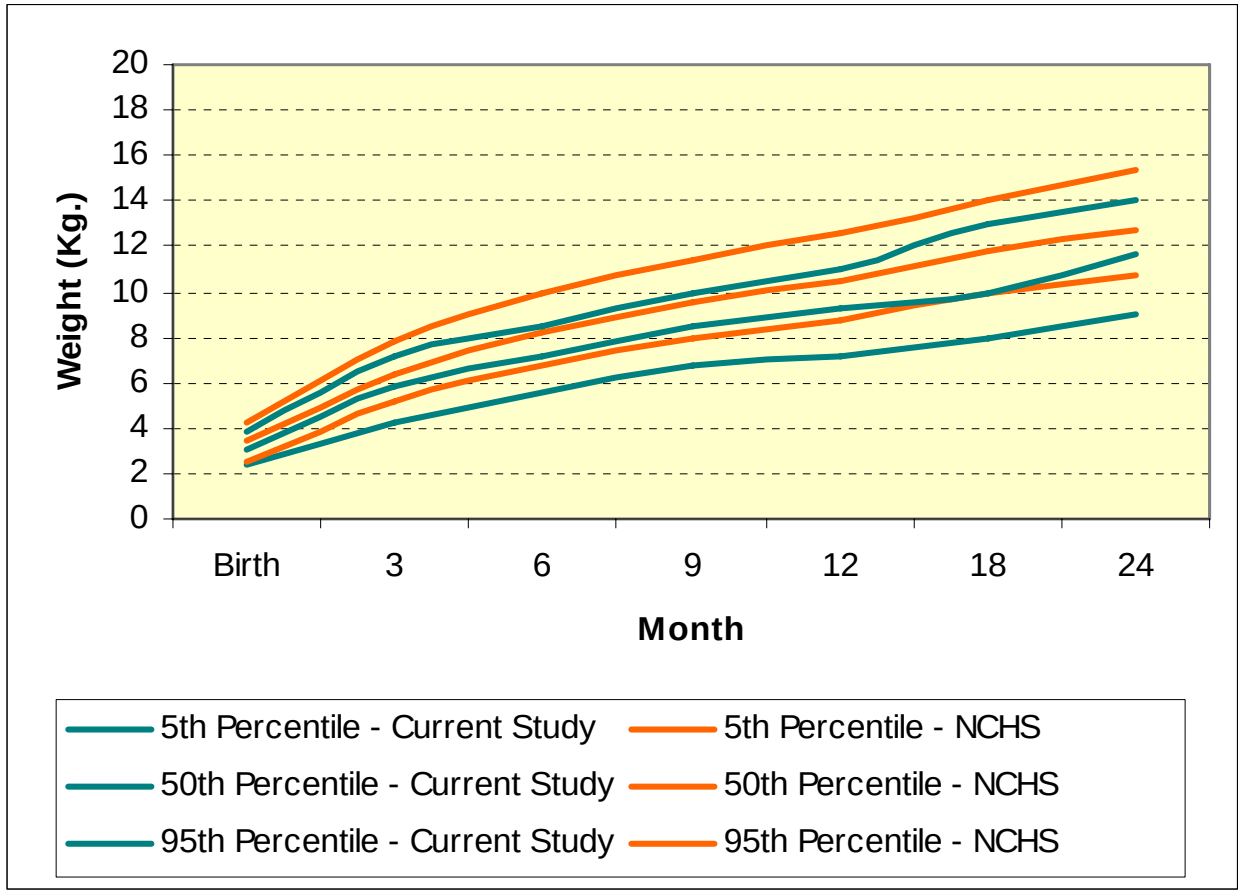

Figure-4

Comparison of Weight (Kg) of Girls between NCHS [1] & Present study

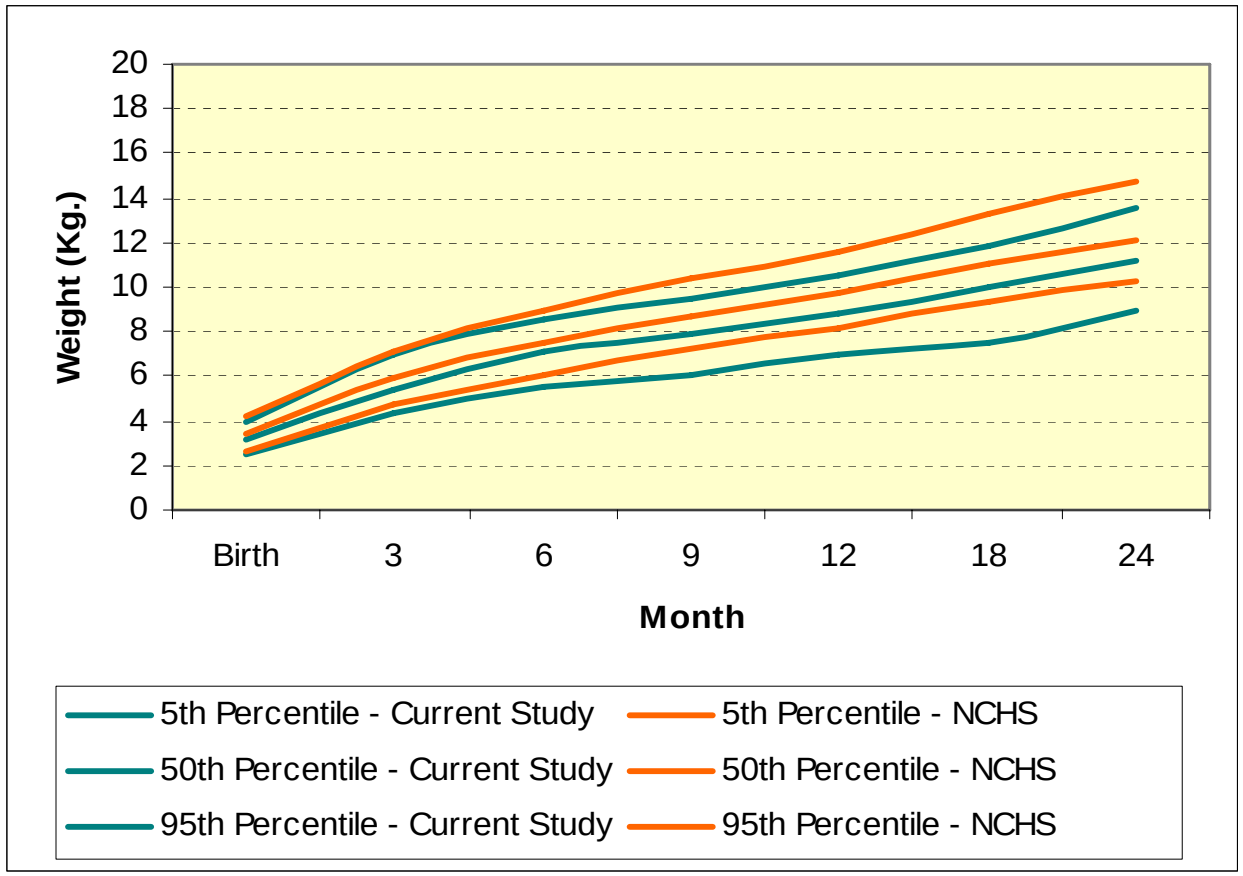

Figure-3 shows Comparison of Weight(Kg) of Boys between NCHS [1], & Present study. The figure shows the 5th, 50th, 95th percentile Weight values of this study compared with NCHS [1].

Figure-4 shows Comparison of Weight(Kg) of Boys between NCHS [1], & Present study. The figure shows the 5th, 50th, 95th percentile Weight values of this study compared with NCHS [1].

DISCUSSION

India is a signatory of millennium developmental goals (MDG) by 2020 and marches towards the achievement of goals. Health planners and policy makers allocate resources towards health care based on the infant, maternal mortality rates. Inspite of generous allocation of funds neonatal mortality rate and low birth weight in India are still at a very high level. This puts a question mark over the ability of our country MDG by 2020. To achieve this goal health planning is important.

The purpose of this study is to facilitate the health planner through classification of nutritional status and thus providing an objective basis for decision-making in relation to care. The precise criteria that are used to interpret growth chart data and to define the levels of care requirements must be based on local needs, resources and service patterns.

Increase in body size is a biological phenomenon that can be readily observed and easily measured, even under the simplest conditions. In man, the patterns of physical growth in an individual or community are the result of genetic characteristics and environmental influences, among which infectious disease and

dietary intake are of particular importance in the developing areas of world. For this reason, the measurement and interpretation of growth in childhood has become one of the most widespread instruments for the assessment of individual and community health and nutritional status. The frequency with which this type of measurement is used has given rise to a wide variety of systems for recording and interpreting data, ranging from complex research grids incorporating several variables to simple charts indicating weight-for-age.

The standards used for purposes of comparison vary widely, as do the systems for classification of growth deviation, not only from country to country but among areas within the same country. This proliferation of charts, standards and systems of classification has given rise to confusion in health services as to which is the most desirable for local use, as well as for regional and international comparisons.

Habicht et al[10] stated that there are small differences 3% for height and 6% for weight in different ethnic groups with similar socio-economic status. In contrast, the varying socio-economic status can have higher difference (12% for height & 30% for weight). Therefore, these workers recommended that both genetic

and ecologic background as well as their mutual interaction be taken into account in the construction of growth references.

Goldstein and Tanner[11] , Tanner[12] have argued for local standards, which need to be updated from time to time to account for changing socio-economic level.

The use of western standards set unattainable goal and overestimate degree of under nutrition among children. The same could be avoided using local attainable standards[13,14] .

Vanloon et al [15] working in 4 different geographical areas showed that growth curves had heterogeneity as well as the values had varying differences as compared to NCHS standard for individual age points.

In our country, growth charts/ road to health cards/ child health card/ weight for age charts in practice are basically derived from the growth charts designed showing upper line NCHS[1] 50th centile of weight and the lower line being 3rd centile.

The 50th weight centile for boys upto 12 months approach around 10- 25th percentile and between 5th – 10th percentile for age 18-24 months compared to NCHS standards [1]. For girls, the 50th weight centile of the present is near 25-50th centile upto 6 months,

thereafter upto 24 months between 10-25th centile compared to NCHS[1] standards.

In height for age the 50th percentile line for both boys and girls of this study fall below the 5th percentile line of the NCHS growth chart [1]. Similarly the 95th percentile line of this study fall below the 50th percentile line of the NCHS growth chart [1]. Similar findings were observed in the study by Agarwal et al [2] .

The 50th percentiles of head circumference in both boys and girls were higher than the 50th percentiles of chest circumference from birth to 12 months. The chest circumference equalized head circumference at 1 year and thereafter Chest circumference is more than the head circumference. Similar findings were observed in the study by Agarwal et al [2] .

The comparative data for head & chest circumference in Table (16 & 17) shows that both parameters are smaller in Indian children when compared to western standards.

The mid arm circumference is not significant up to one year of age but it is included for completion purpose and the results were given in the table 10 & 11.

The 50th percentiles values of mid arm circumference in boys and girls were similar with only marginal difference

The maximum increment in mid arm circumference appear to be in the first 9 months of age. Thereafter, the increments were smaller and similar. Similar findings were observed in the study by Agarwal et al [2] .

Thus, it could be said that Growth level attainable in India be used on regional basis to avoid overestimate of under nutrition. The need for continuous efforts to collect data for growth parameters in a nation wide approach will ultimately provide an assessment measured for optimal growth potential.

CONCLUSION

- The 50th percentile values for weight, length, head circumference were comparatively lower than the western standards.
- The use of western standards set unattainable goal and overestimate degree of under nutrition among children.
- The use of local standards on regional basis avoids overestimate of under nutrition.
- Continuous efforts to collect data for growth parameters in a nation wide approach should be made to provide for assessment of optimal growth potential.
- It is recommended to use the growth charts developed from this study for the Chennai population to monitor the growth pattern and to identify the children who are really undernourished.

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ANNEXURE - I

PROFORMA

Age:

Sex:

Date of Birth:

Birth weight:

Weight (Kg):

Length (cm):

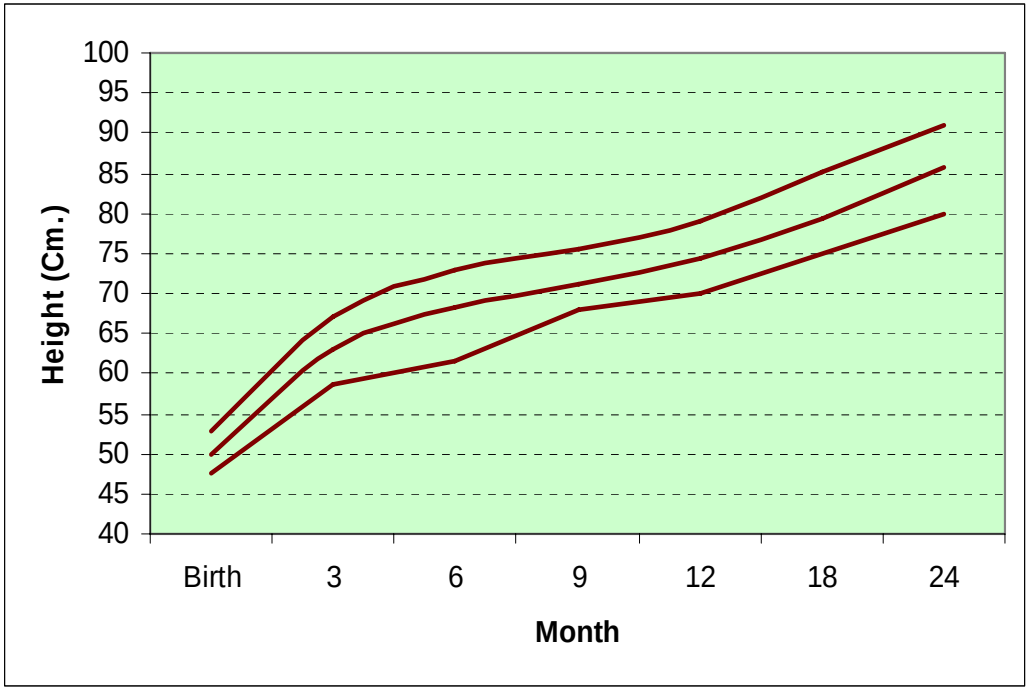
Head circumference (cm):

Chest circumference (cm):

Mid arm circumference (cm):

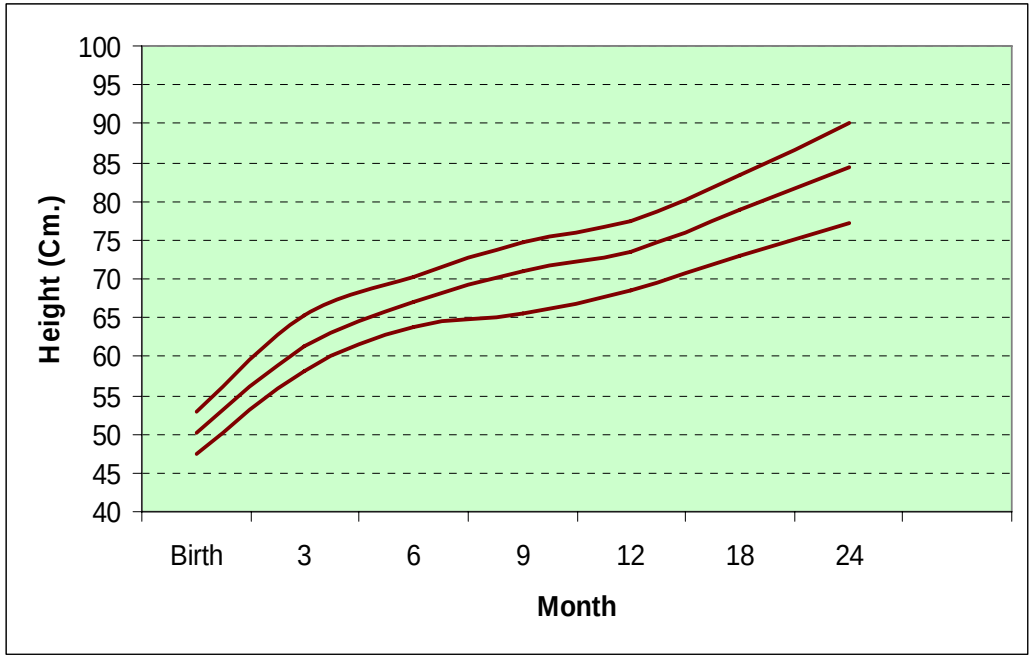
ANNEXIRE - II

Length for age percentile curves for boys birth to 2 yr.



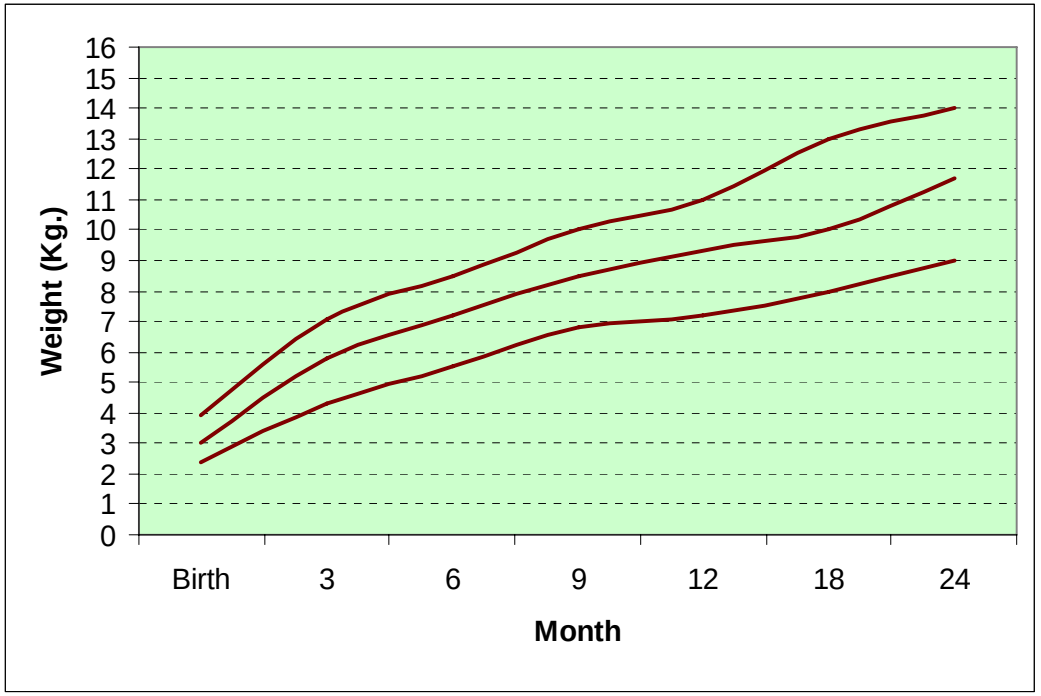
ANNEXIRE - III

Length for age percentile curves for girls birth to 2 yr.



ANNEXIRE - IV

Weight for age percentile curves for boys birth to 2 yr.



ANNEXIRE - V

Weight for age percentile curves for girls birth to 2 yr.